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ABSTRACT OF DISSERTATION

GENERALIZED CONVECTIVE AVAILABLE POTENTIAL ENERGY AND ITS APPLICATION TO CUMULUS PARAMETERIZATION

Based on the concept of Moist Available Energy (MAE) of Lorenz (1978, 1979), the Generalized Convective Available Potential Energy (GCAPE) was defined as the vertical component of the MAE and a measure of the conditional instability of a column atmosphere. The GCAPE represents the potential energy available for convection. Unlike conventional measures of convective available potential energy (CAPE), the GCAPE includes the effects of multiple parcels originating at multiple levels, and also the effects of compensating motions in the environment. The modified Lorenz Parcel-Moving Algorithm for calculating GCAPE was presented. Ice effects were included, based on the approach of Ooyama (1990). The GCAPE of Global Atmosphere Research Program's Atlantic Tropical Experiment (GATE) Phase III data was analyzed.

The Lorenz algorithm is a Lagrangian algorithm. To be better suited for modeling and other application, an Eulerian "penetrator" algorithm is proposed. The results from the penetrator algorithm are discussed.

As one of its applications, the GCAPE has been used in a cumulus parameterization. By using Nitta's (1975) model, the cloud-base mass flux for each cloud type can be calculated diagnostically. Through a key assumption in which the GCAPE and its related reference state are used, we can use Nitta's model to calculate the cloud-base mass flux in a prognostic way. With the cloud-base mass flux known, the Arakawa-Schubert (1974) model can be used to obtain the cloud properties and the feedbacks of convection on the large-scale fields. The effects of downdrafts were included by following Johnson's (1976) scheme. We related the adjustment time scale to the GCAPE production rate of large-scale processes. The proposed cumulus parameterization has been tested with GATE Phase III data. The calculated precipitation rate, warming and drying of the large-scale fields by convection are generally similar to those observed. Problems of the proposed cumulus parameterization are also discussed. Including the anvil cloud effects in a more detailed way is a key remaining problem.

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